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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. ER439200304US

INVENTOR(S)

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Additional inventors are being named on the ____________ *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

ULTRA-DEEPWATER FLOATING PLATFORM

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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☐ Firm or Individual Name					
Address					
Address					
City		State		Zip	
Country		Telephone		Fax	

ENCLOSED APPLICATION PARTS *(check all that apply)*

☑ Specification *Number of Pages* 10

☑ Drawing(s) *Number of Sheets* 3

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number ____________

☐ Other (specify) ____________

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.

☑ A check or money order is enclosed to cover the filing fees.

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FILING FEE Amount ($): $160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: ____________

Respectfully submitted,

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Date 04-06-04

REGISTRATION NO. 29,573
(if appropriate)
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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

ATTORNEY DOCKET NO. SEAH/511PROV

PROVISIONAL APPLICATION FOR UNITED STATES
LETTERS PATENT

FOR

ULTRA-DEEPWATER FLOATING PLATFORM

BY

STEVEN J. LEVERETTE

ORIOL R. RIJKEN

ULTRA-DEEPWATER FLOATING PLATFORM

BACKGROUND OF THE DISCLOSURE

The present invention relates offshore floating platforms, more particularly to tension leg platforms (TLP) for installation in ultra-deepwater, i.e., 8,000 – 10,000 ft water depth.

TLPs are floating platforms that are held in place in the ocean by means of vertical structural mooring elements called tendons, which are typically fabricated from high strength, high quality steel tubulars, and include articulated connections on the top and bottom (tendon connectors) that reduce bending moments and stresses in the tendon system. Many factors must be taken into account during the design of the tendon system to keep the TLP safely in place including: (a) limitation of stresses developed in the tendons during extreme storm events and while the TLP is operating in damaged conditions; (b) avoidance of any slackening of tendons and subsequent snap loading or disconnect of tendons as wave troughs and crests pass the TLP hull; (c) allowance for fatigue damage which occurs as a result of the stress cycles in the tendons system throughout its service life; (d) limit natural resonance (heave, pitch, roll) motions of the TLP to ensure adequate functional support for personnel, equipment, and risers; and (e) vibrations in the platform system arising from vortex-induced vibrations.

TLPs have been noted in the past to be water depth limited to water depths of 3000', or 4000', or 5000', or 6000', depending on when and who is asked. The primary limitation in extending the limits for TLP applications has been the cost and weight penalty for maintaining tendon stiffness to prevent natural periods of heave/pitch/roll from becoming longer than the commonly accepted 2-4 seconds. Keeping these response

periods short prevents them from being excited at resonance by direct (first order) wave energy. In order to maintain the same stiffness as shallower depth systems, a tendon must be increased in area by a ratio similar to the ratio of length increase. In simple terms, the tendon mass increases as the third power of the water depth. As the tendon mass increases in increasing water depths, the tendon also adds to the system primary mass for heave/pitch/roll modes, and requires additional stiffness to maintain the same modal periods. As a consequence, the traditional approach to TLPs is limited by increased cost, and by decreased payload, with increasing water depth, the limit depending on the levels of optimization employed and the cost sensitivity of the application.

It is therefore an object of the present invention to provide a floating platform system including a hull design to limit maximum tendon loads and aid in inhibiting resonant responses in the platform system leading to better motions for personnel, equipment and riser support, and to lighter and lower cost tendon systems.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the above recited features, advantages and objects of the present invention are attained can be understood in detail, a more particular description of the invention briefly summarized above, may be had by reference to the embodiments thereof which are illustrated in the appended drawings.

It is noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

Fig. 1 is a side view of a mono-column floating platform;

Fig. 2 is a partial perspective view of a conventional four-column floating platform;

Fig. 3 is a partial perspective view of a four-column floating platform of the present invention;

Fig. 4 is a partial perspective view an alternate embodiment of a four-column floating platform of the present invention; and

Fig. 5 is a table of tension responses for different floating platform configurations.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring first to Fig. 1, a mono-column floating platform generally identified by the reference numeral 10 is shown. The floating platform 10 includes a column or hull member 12 projecting above the water surface 14 supporting a platform deck 16 thereon. Pontoons 18 extend radially outward from the base of the hull 12. The floating platform 10 is anchored to the seabottom 20 by tendons 22.

In a typical tendon design, steel tendons are utilized to secure the floating platform to the seabottom. As exploration and production of oil reserves expand into deeper waters, the design of the tendon system becomes more critical and begins to dominate the platform costs. The tendon system must be designed to operate between tolerable minimum and maximum tensions, to restrict natural resonance motions, and to limit the fatigue damage caused by each stress cycle. The latter two are typically accomplished by increasing the cross-sectional area of the steel tendon, which increases the tendon axial stiffness. But this increases the weight of the tendon and reduces the payload carrying capacity of the floating platform.

In accordance with the present invention, reducing tension response is accomplished by changing the hull form or configuration for the ultra-deepwater platform installations. A mono-column TLP configuration is shown in Fig. 1. Alternate configurations are shown in Figs. 2 – 4. The TLP 10 of Fig. 1 (and payload) is located in a water depth of 8500 ft. The axial stiffness of the tendons 22 is taken to be 300 kips/ft per tendon. The alternate platform configurations of Figs. 2 - 4 include variations in hull geometry with a number of constraints to provide comparable cases to the reference TLP 10. Each alternate platform configuration has the same hull weight, gyradii, payload and displacement as the reference TLP 10. The location of the tendon porch is allowed to vary by configuration. It is assumed that the porches are located at the tips of the pontoons 18; pontoon lengths may vary between the configurations.

Referring now to Fig. 2, a four-column conventional TLP platform 30 is shown. The platform 30 includes four columns 32, one at each corner, interconnected by horizontal members 34. The columns 32 project above the water surface and support a platform deck thereon. The platform 30 is anchored to the seabottom by tendons, two at each column 32. The draft and column/pontoon ratio are similar to the platform 10. In a performance evaluation based on the tendon tension response, the platform 30 performed better than the platform 10, but not as good as the platform configurations shown in Figs. 3 and 4. Also, an important consideration with the platform 30 is the addition of two tendons, for a total of eight, which will have a substantial cost impact in 8500 ft water depth.

Referring now to Fig. 3, a platform 40 includes three columns 42 located at the distal ends of each pontoon 18. Increasing the size of these outer columns 42, while

maintaining the same water plane area (reducing the central column 12), typically results in an increase of heave response and a decrease in roll/pitch response over most of the wave frequency range. Simulations analysis indicate that tension RMS values under fatigue sea states are best when the outer column 42 is less than half the diameter of the central column 12. However, for hurricane sea states, the tension RMS values are best when the outer column 42 is approximately the same diameter as the central column 12. Overall, the tension RAO of the platform 40 is significantly less than that of the mono-column platform 10.

Referring to Fig. 4, a platform 50 includes three battered outer columns 52 located at the distal ends of each pontoon 18. The slight batter of the outer-columns 52 substantially reduce the tension RMS under fatigue conditions, while the tension RMS under hurricane conditions is barely affected. There appears to be an optimum batter angle of less than 10 degrees, with a value of 6 to 8 degrees as more typical. The optimum angle appears to be dependent on the volumetric ratio of pontoon and column.

The performance evaluation of each TLP configuration, summarized in Fig. 5, is based on the tendon tension response. An estimate of the tension RMS, an indicator of fatigue damage and extreme loads, is computed for a fatigue sea state and for a 100-year hurricane sea state. The comparison is based on relative performance of fatigue sea state results, and relative performance of hurricane sea state results.

Some of the findings are expected, for example the effect of deeper draft and longer pontoons is part of the consideration given in current design practices. In system design, these are partially balanced by increases in cost of the hull to achieve these improvements.

The addition of the three end-of-pontoon columns 42, 52 takes the traditional mono-column triangular shape and changes it from a mono-column design to a multi-column design. As has been seen in semi-submersible design, the phase differences between loads on multi-column structures produce cancellation between columns and resultant improvements in motions and total loads. The disadvantage is generally greater internal racking and squeeze/pry loadings into the structure itself. Also, for the mono-column platform, the substantial change between a deck supported on a single column and one supported between four columns, with the introduction of hull loads into the deck, produces a substantial change in the way the deck will have to be designed and analyzed.

The battered columns configuration was something of a surprise. The original reason for inclusion of battered columns was to provide a better load path for support of the deck. In evaluating the results, however, the improvement due to the battered columns 52 appears to be due to the fact that the inclination gives the columns 52 pontoon-like properties. The portion of the columns 52 that is not under the shadow of the surface water plane has water acting both above and below, whereas the portion of the column 52 that is under the shadow of the surface water plane has water acting only from below. As a result, it is possible to modify the balance between surface piercing and non-surface piercing buoyancy without changing the actual dimensions of the pontoons and columns. Since designers are typically limited structurally to the amount of displacement that they can allocate to the pontoons without the column getting structurally too "skinny", especially in deep draft configurations, battering the columns enables better optimization of the pontoon/column.

Referring still to Fig. 5, it will be observed that the four column conventional TLP 30 has better performance per tendon than the mono-column TLP 10 and a deep draft mono-column TLP, but this is tempered by the need for two additional tendons 22 for the TLP 30. However, it is clear that the four-column TLP 40 has better performance than the conventional TLP 10, especially in the fatigue sea states. In ultra-deep water, the cost of providing and installing additional tendons and piles is likely to give the four-column TLP 40 even more advantage over a conventional TLP 10.

In conclusion, the results summarized in Fig. 5 give substantial guidance in optimizing the platform hull form for ultra-deep water installations. The addition of multi-column configurations will open the opportunity for free floating stability, including possible major changes in installation costs over the crane assisted ballasting and offshore deck installation currently used. The use of the triangular base and radiating pontoons keeps some of the benefits of the mono-column TLP (fewer tendons, constraint of the risers at the keel, simple geometry to increase baseline), while substantially improving the performance and costs in ultra-deep water.

While a preferred embodiment of the invention has been shown and described, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims which follow.

CLAIMS:

1. A floating platform, comprising:

a) a central column having an upper end and a lower end;

b) pontoons extending radially outward from said lower end of said central column;

c) outer columns located at the distal ends of said pontoons, said outer columns extending substantially vertically;

d) a deck supported above the water surface on said central column and said outer columns; and

e) anchor means securing said floating platform to the seabottom.

2. The floating platform of claim 1 wherein said outer columns are battered.

3. The floating platform of claim 2 wherein the batter angle is less than 10 degrees.

4. The floating platform of claim 3 wherein the batter angle is in the range of 6 to 8 degrees.

5. A method of minimizing floating platform tendon tension response in ultra-deep water comprising installing said platform in a body of water and anchoring said platform to the seabottom, wherein said platform compries:

a) a central column having an upper end and a lower end;

b) pontoons extending radially outward from said lower end of said central column;

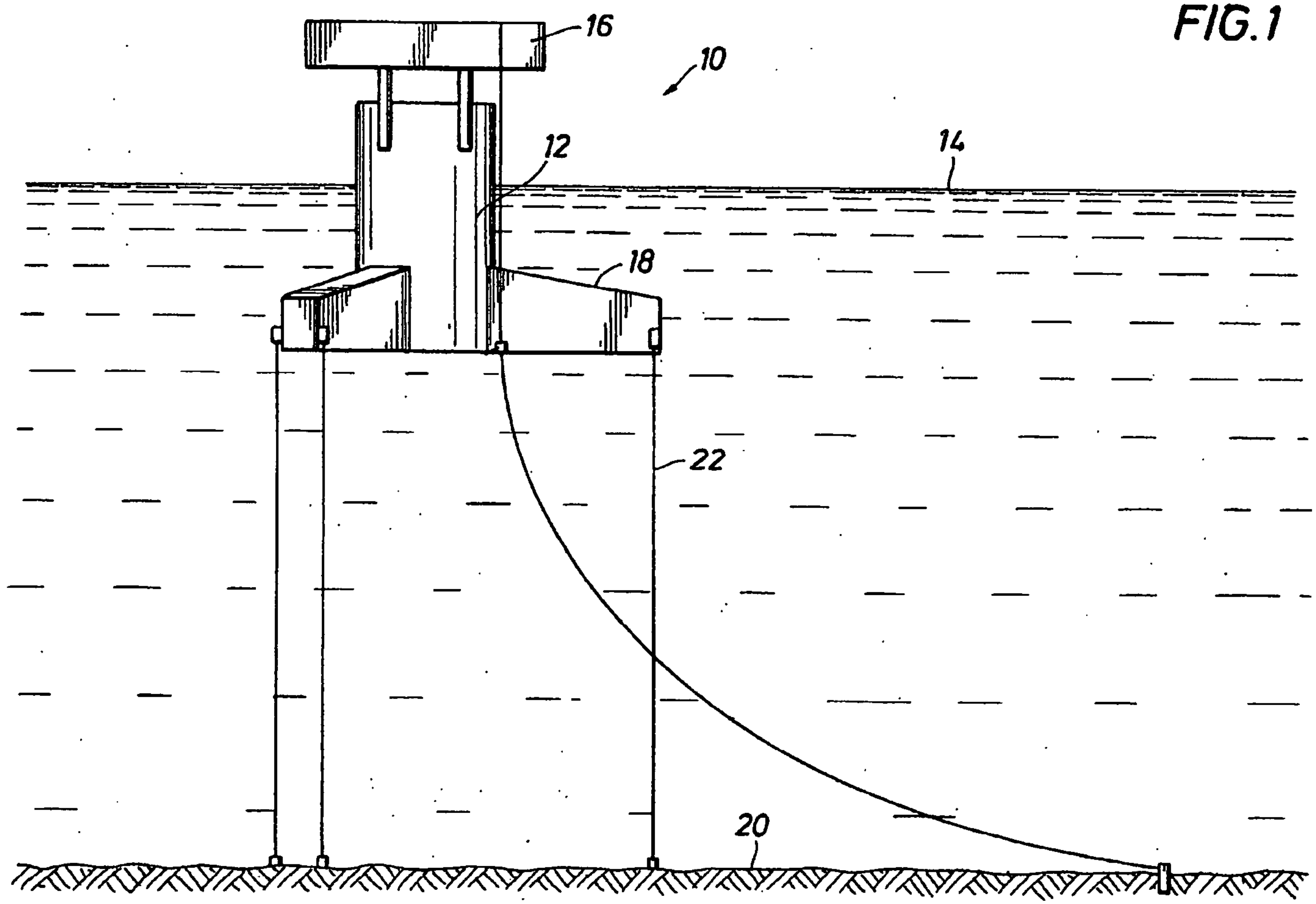
c) outer columns located at the distal ends of said pontoons, said outer columns extending substantially vertically; and

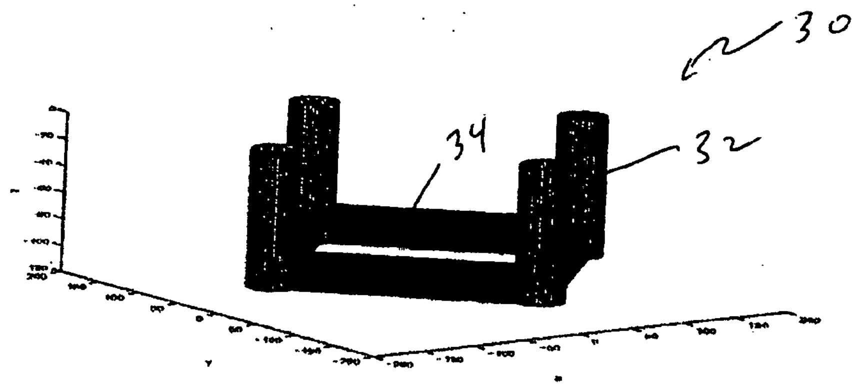
d) a deck supported above the water surface on said central column and said outer columns.

ABSTRACT

A floating platform system includes a hull design configurations for limiting maximum tendon loads and aiding in inhibiting resonant responses in the platform system leading to better motions for personnel, equipment and riser support, and to lighter and lower cost tendon systems

FIG.1

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32
34

FIG. 2

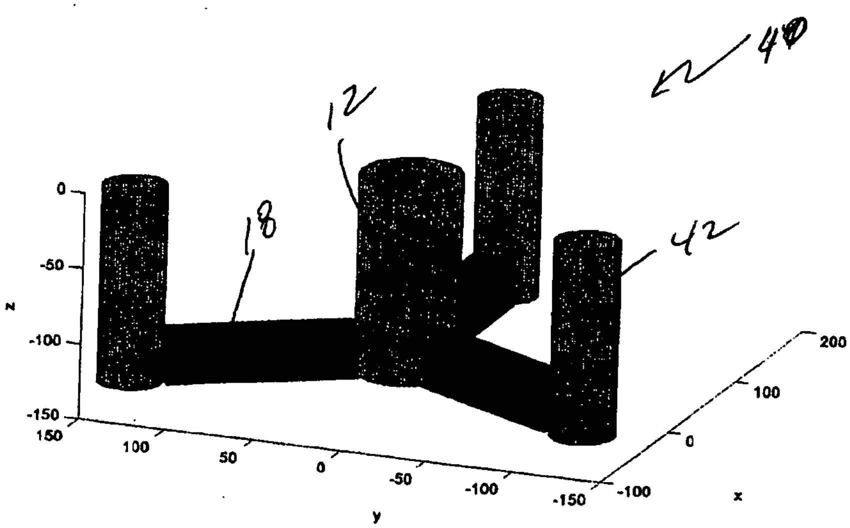
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FIG. 3

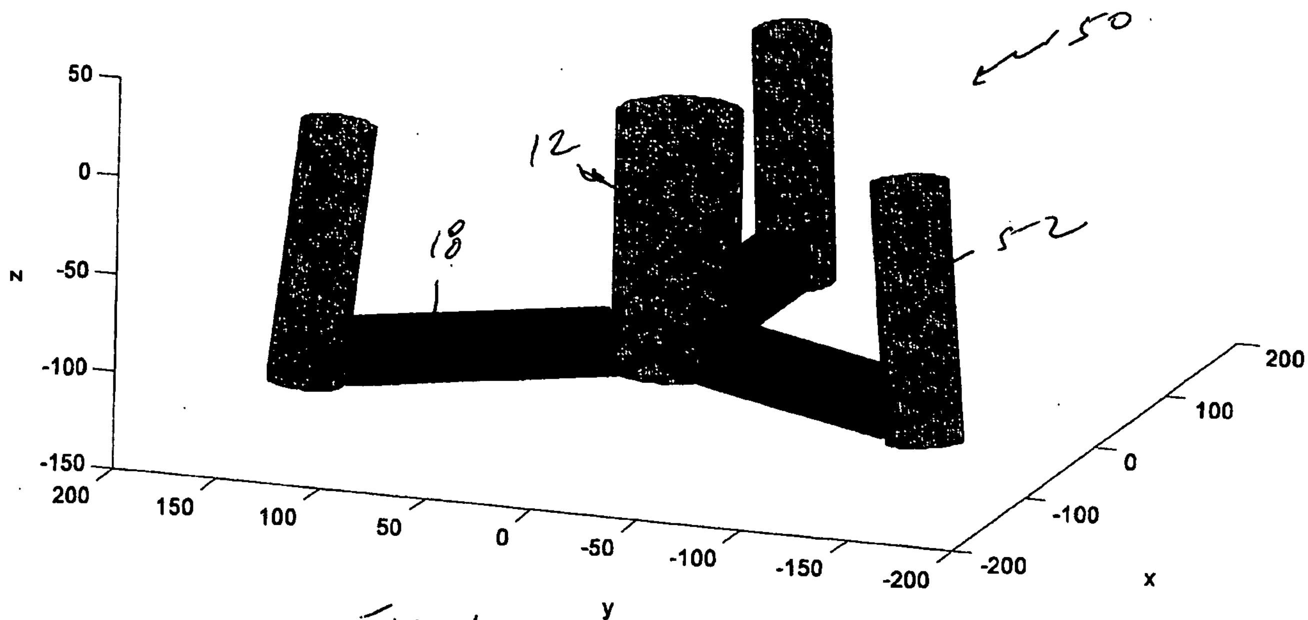
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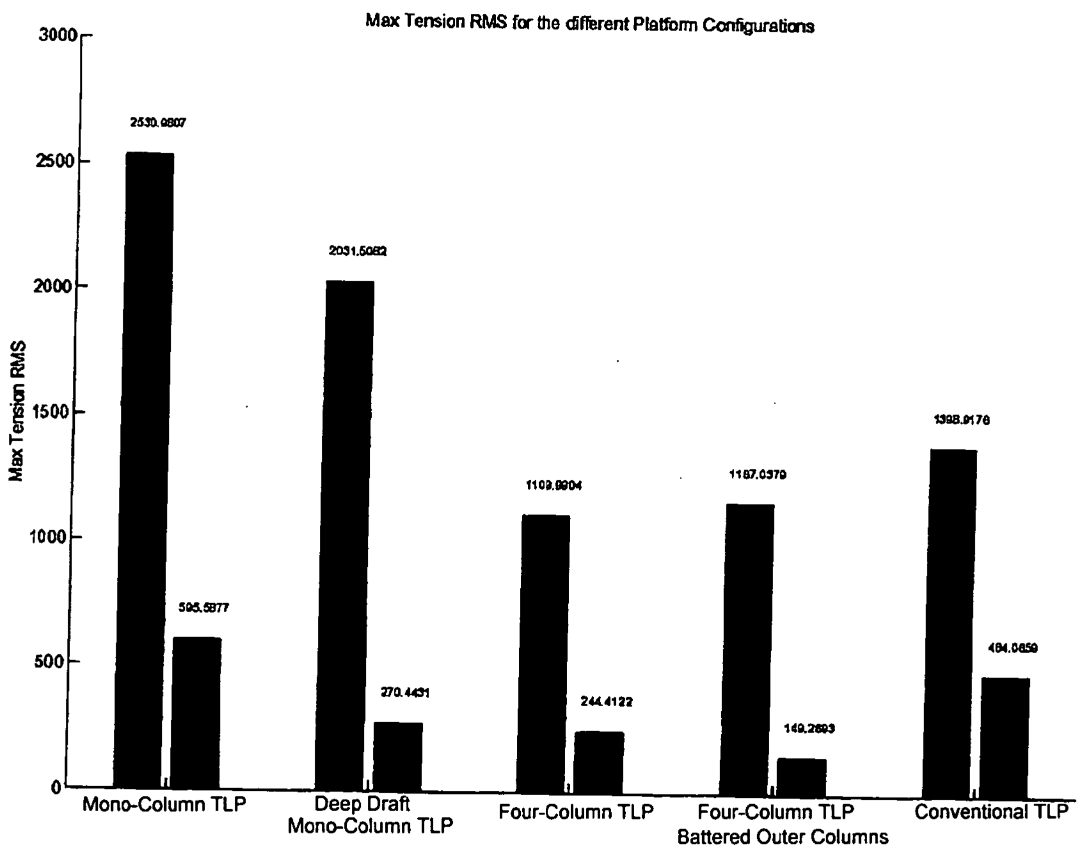
FIG. 4


Max Tension RMS for the different Platform Configurations
Max Tension RMS
3000
2500
2000
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1000
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244.4122
1187.0379
149.2693
Mono-Column TLP
Deep Draft
Mono-Column TLP
Four-Column TLP
Four-Column TLP
Battered Outer Columns
Conventional TLP

FIG. 5